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Novel Multifunction Filter Using Current Feedback Amplifier

Dr. Nisha Walde, Mr. Prashant Kumar Mavi
IIMT, Greater Noida, Uttar Pradesh, India
Nisha.walde1@gmail.com, prashantmavi@gmail.com

ABSTRACT

One configuration for realizing voltage- mode multifunction filters using current feedback amplifiers (CFOA) is presented. The proposed voltage -mode circuit exhibit simultaneously low pass and band pass filters. The proposed circuits offer the following features: No requirements for component matching conditions; low active and passive sensitivities; employing only grounded capacitors and the ability to obtain multifunction filters from the same circuit configuration.

Keywords: Active Filter, Current Feedback, Operational Amplifier, Voltage-Mode

1 Introduction

The current feedback amplifier (CFOA) can provide not only constant bandwidth independent of closed-loop gain but also high slew-rate capability. Thus, it is beneficial to use a current feedback operational amplifier as a basic building block to realize analogue signal processing circuits [1].

In 1992, Fabre proposed a voltage-mode band pass and high pass filters circuit by using two CFOAs, one grounded capacitor, one floating capacitor and three resistors. In 1993, Fabre proposed another voltage-mode or current-mode biquads[2-3]. The voltage-mode biquad exhibits simultaneously band pass and high pass filters by using one CFOA, one grounded capacitor, one floating capacitor and two resistors. The current-mode biquad exhibits simultaneously band pass and high pass filters by using one CFOA, two grounded capacitors and two resistors. Several single-CF0A voltage-mode biquads were proposed. However, only one filter function (low pass, band-pass or high pass) can be obtained in each realization, which implies the need to change the circuit topology to obtain other types of filter functions. Moreover, these single-CFOA voltage-mode biquads employ floating capacitors. In 1995 ,Liu proposed four voltage-mode biquads with high input impedance for realization low pass, band-pass or high pass filters by using two CFOAs, two (or three) capacitors and three (or two) resistors. In 1996 [2], Soliman proposed many voltage-mode biquadratic filter circuits. The four two-CFA biquads in [9-11] realize low pass and band pass filters simultaneously and using only grounded capacitors.

In this paper, a new configuration is proposed to realize voltage -mode low pass and band pass filters simultaneously by using one CFOA, two grounded capacitors and three resistors. One more filtering signal can be obtained with respect to the previous single-CFOA biquads in [3-7] and two-CFOA biquads in [5]. With respect to the voltage-mode biquads in [3], the proposed circuit uses only grounded capacitors. The use of grounded capacitors makes the proposed circuit attractive for integrated circuit implementation

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[8]. With respect to the voltage-mode two-CFOA low pass and band pass biquads in [10], the proposed circuit uses one less active components.

One new configuration is proposed to realize current-mode low pass, band pass and high pass filters simultaneously. One more filtering signal can be obtained with respect to the previous current-mode biquad in [5]. Critical component matching conditions are not required in the design of proposed circuit.

2 Voltage-Mode Circuit

Using standard notation, the port relations of a CFOA can be characterized by vx=vy,v0=vz,iz=ix and iy=0.The proposed voltage mode circuit is shown in Figure 1.The output transfer functions of Fig.1can be expressed as

$$\frac{Vlp}{\text{Vin}} = \frac{-\text{G1G3}}{\text{s}^2\text{C1C2}+\text{sC2(G1+G2+G3)}+\text{G2G3}} \tag{1}$$

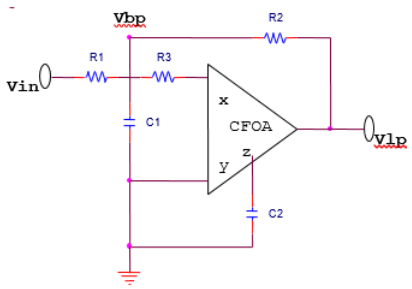


Figure 1.The proposed voltage-mode lowpass and bandpass filter.

$$\frac{\text{Vbp}}{\text{Vin}} = \frac{-\text{sC2G1}}{\text{s}^2\text{C1C2}+\text{sC2(G1+G2+G3)}+\text{G2G3}} \tag{2}$$

Thus, the circuit realizes an inverting low pass signal at V_{lp} and a non-inverting band pass signal at V_{bp}, simultaneously.The circuit has two grounded capacitors, three resistors and only one CFOA.The output impedance of the CFOA at v_0 is very small.

The output terminal of V_{lp} can be directly connected to the next stage. The various parameter values of Fig 1 are given by:

$$w0 = \sqrt{\frac{G2G3}{C1C2}} \quad , \quad \frac{w0}{Q} = \frac{G1+G2+G3}{C1} \text{ and}$$

$$Q = \frac{1}{G1+G2+G3}\sqrt{\frac{C1G2G3}{C2}} \tag{3}$$

The gain constants are

$$\text{Ho}(lp) = -\frac{G1}{G2} \quad \text{and}$$

$$\text{Ho}(bp) = -\frac{G1}{G1+G2+G3} \tag{4}$$

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3 Experimental Results

Experiments were carried out to demonstrate the feasibility of the proposed circuits. The CF0A was implemented using one AD844.figure 2(a) and (b) represent the frequency responses for the low pass and band pass filters of figure 1,respectively,designed with $c_1=C_2=10pF$ and $R_1=R_2=R_3=1k\Omega$.Experimental results confirm the theoretical analysis

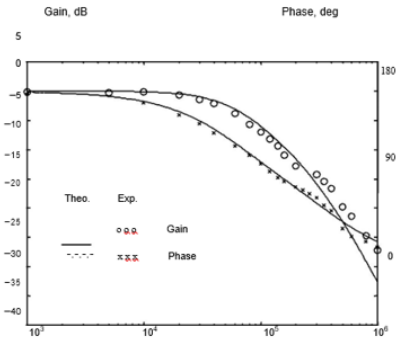


Figure-1: Frequency, Hz

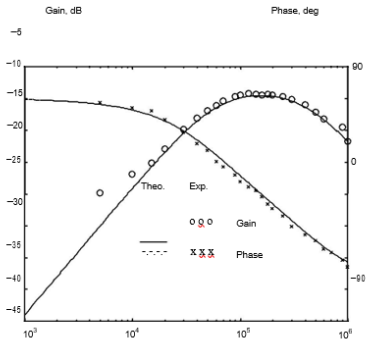


Figure-2: Frequency, Hz

4 Conclusions

In this paper, a configuration for realizing voltage-mode filters using CFOAs are presented.

The proposed voltage-mode circuit exhibits simultaneously low pass and band pass filter by using one CFOA.The proposed circuits have no requirements for component matching conditions. This circuit possesses another advantage of filter design applications. The simulation results confirm the theoretical conclusions very well.

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